

## CLAIMS

1. A coding apparatus comprising:
  - a down-sampling section that lowers a sampling rate
  - 5 of an input signal;
  - a base layer coding section that encodes an input signal of which sampling rate is lowered and obtains first coding information;
  - a decoding section that generates a decoded signal
  - 10 based on said first coding information;
  - an up-sampling section that raises a sampling rate of said decoded signal to a rate identical to that of said input signal;
  - an enhancement layer coding section that uses a
  - 15 parameter generated in decoding processing of said decoding section, encodes a difference value between said input signal and said decoded signal of which sampling rate is raised, and obtains second coding information; and
  - 20 a multiplexing section that multiplexes said first coding information and said second coding information.
2. The coding apparatus according to claim 1, wherein said base layer coding section encodes an input signal
- 25 using code excited linear prediction.
3. The coding apparatus according to claim 1, wherein said enhancement layer coding section encodes an input

signal using orthogonal transformation.

4. The coding apparatus according to claim 3, wherein  
said enhancement layer coding section encodes an input  
5 signal using MDCT processing.

5. The coding apparatus according to claim 1 through  
claim 4, wherein said enhancement layer coding section  
performs coding processing using the base layer LPC  
10 coefficients generated in decoding processing of said  
decoding section.

6. The coding apparatus according to claim 5, wherein  
said enhancement layer coding section converts the base  
15 layer LPC coefficients to the enhancement layer LPC  
coefficients based on a preset conversion table,  
calculates a spectral envelope based on the enhancement  
layer LPC coefficients, and uses said spectral envelope  
in at least one of spectrum normalization or vector  
20 quantization in coding processing.

7. The coding apparatus according to claim 1, wherein  
said enhancement layer coding section performs coding  
processing using a pitch period and pitch gain generated  
25 in decoding processing of said decoding section.

8. The coding apparatus according to claim 7, wherein  
said enhancement layer coding section calculates a

spectral fine structure using a pitch period and pitch gain, and uses said spectral fine structure in spectrum normalization and vector quantization in coding processing.

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9. The coding apparatus according to claim 1, wherein said enhancement layer coding section performs coding processing using power of a decoded signal generated by said decoding section.

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10. The coding apparatus according to claim 9, wherein said enhancement layer coding section quantizes a fluctuation amount of power of MDCT coefficients based on power of a decoded signal, and uses said quantized MDCT coefficient power fluctuation amount in power normalization in coding processing.

11. The sound coding apparatus according to claim 1, further comprising:

20 a subtraction section that obtains an error signal from a difference between an input signal at the time of input and a decoded signal of which sampling rate is raised; and

a frequency determination section that determines the frequencies subject to coding of said error signal based on a decoded signal of which sampling rate is raised;

25 wherein said enhancement layer coding section encodes said error signal at said frequencies.

12. The sound coding apparatus according to claim 11,  
further comprising an auditory masking section that  
calculates auditory masking that indicates an amplitude  
5 value that does not contribute to hearing;

wherein said enhancement layer coding section  
determines an object of coding so that a signal within  
said auditory masking is not made an object of coding  
in said frequency determination section and encodes an  
10 error spectrum that is a spectrum of said error signal.

13. The sound coding apparatus according to claim 12,  
wherein:

said auditory masking section comprises:  
15 a frequency domain transformation section that  
transforms a decoded signal of which sampling rate is  
raised to frequency domain coefficients;

an estimated auditory masking calculation section  
that calculates estimated auditory masking using said  
20 frequency domain coefficients; and

a determination section that finds a frequency at  
which an amplitude value of a spectrum of said decoded  
signal exceeds an amplitude value of said estimated  
auditory masking;

25 and said enhancement layer coding section encodes  
said error spectrum located at said frequency.

14. The sound coding apparatus according to claim 13,

wherein:

said auditory masking section comprises an estimated error spectrum calculation section that calculates an estimated error spectrum using said  
5 frequency domain coefficients; and

said determination section finds the frequencies at which an amplitude value of said estimated error spectrum exceeds an amplitude value of said estimated auditory masking.

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15. The sound coding apparatus according to claim 13, wherein:

said auditory masking section comprises a correction section that smoothes estimated auditory  
15 masking calculated by said estimated auditory masking calculation section; and

said determination section finds the frequencies at which an amplitude value of said decoded signal spectrum or said estimated error spectrum exceeds an amplitude  
20 value of smoothed said estimated auditory masking.

16. The sound coding apparatus according to claim 13, wherein said enhancement layer coding section calculates for each frequency an amplitude value difference between  
25 either an estimated error spectrum or error spectrum and either auditory masking or estimated auditory masking, and determines an amount of coding information based on the amount of said amplitude value difference.

17. The sound coding apparatus according to claim 13,  
wherein said enhancement layer coding section encodes  
said error spectrum in a predetermined band in addition  
5 to the frequencies found by said determination section.

18. A decoding apparatus comprising:  
a base layer decoding section that decodes first  
coding information in which an input signal is coded in  
10 predetermined base frame units by a coding side and obtains  
a first decoded signal;  
an enhancement layer decoding section that decodes  
second coding information and obtains a second decoded  
signal;  
15 an up-sampling section that raises a sampling rate  
of said first decoded signal to a rate identical to that  
of said second decoded signal; and  
an addition section that adds said first decoded  
signal of which sampling rate is raised and said second  
20 decoded signal.

19. The decoding apparatus according to claim 18,  
wherein said base layer decoding section decodes first  
coding information generated by code excited linear  
25 prediction.

20. The decoding apparatus according to claim 18,  
wherein said enhancement layer decoding section decodes

second coding information using orthogonal transformation.

21. The decoding apparatus according to claim 20,  
5 wherein said enhancement layer decoding section decodes second coding information using inverse MDCT processing.

22. The decoding apparatus according to claim 18,  
wherein said enhancement layer decoding section decodes  
10 second coding information using the base layer LPC coefficients.

23. The decoding apparatus according to claim 22,  
wherein said enhancement layer decoding section converts  
15 the base layer LPC coefficients to the enhancement layer LPC coefficients based on a preset conversion table, calculates a spectral envelope based on the enhancement layer LPC coefficients, and uses said spectral envelope in vector decoding in decoding processing.

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24. The decoding apparatus according to claim 18,  
wherein said enhancement layer decoding section performs decoding processing using at least one of pitch period or pitch gain.

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25. The decoding apparatus according to claim 24,  
wherein said enhancement layer decoding section calculates a spectral fine structure using a pitch period

and pitch gain, and uses said spectral fine structure in vector decoding in decoding processing.

26. The decoding apparatus according to claim 24,  
5 wherein said enhancement layer decoding section performs decoding processing using power of a decoded signal generated by said decoding section.

27. The decoding apparatus according to claim 26,  
10 wherein said enhancement layer decoding section decodes a fluctuation amount of power of MDCT coefficients based on power of a decoded signal, and uses said decoded MDCT coefficients power fluctuation amount in power normalization in decoding processing.

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28. The sound decoding apparatus according to claim 18, further comprising a frequency determination section that determines the frequencies subject to decoding of second coding information in which a residual error signal of  
20 an input signal and a signal resulting from decoding of first coding information is coded by a coding side based on said up-sampled first decoded signal; wherein:

said enhancement layer decoding section decodes said second coding information using said frequency  
25 information and generates a second decoded signal; and

said addition section adds said second decoded signal and a first decoded signal of which sampling rate is raised.



29. The sound decoding apparatus according to claim 28,  
further comprising an auditory masking section that  
calculates auditory masking that indicates an amplitude  
5 value that does not contribute to hearing;

wherein said enhancement layer decoding section  
determines an object of decoding so that a signal within  
said auditory masking is not made an object of decoding  
in said frequency determination section.

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30. The sound decoding apparatus according to claim 29,  
wherein:

said auditory masking section comprises:

a frequency domain transformation section that  
15 transforms a base layer decoded signal of which sampling  
rate is raised to frequency domain coefficients;

an estimated auditory masking calculation section  
that calculates estimated auditory masking using said  
frequency domain coefficients; and

20 a determination section that finds the frequencies  
at which an amplitude value of a spectrum of said decoded  
signal exceeds an amplitude value of said estimated  
auditory masking;

and said enhancement layer decoding section decodes  
25 said error spectrum located at said frequencies.

31. The sound decoding apparatus according to claim 30,  
wherein:

said auditory masking section comprises an estimated error spectrum calculation section that calculates an estimated error spectrum using said frequency domain coefficients; and

5        said determination section finds the frequencies at which an amplitude value of said estimated error spectrum exceeds an amplitude value of said estimated auditory masking.

10    32.    The sound decoding apparatus according to claim 30, wherein:

      said auditory masking section comprises a correction section that smoothes estimated auditory masking calculated by said estimated auditory masking  
15    calculation section; and

      said determination section finds the frequencies at which an amplitude value of said decoded signal spectrum or said estimated error spectrum exceeds an amplitude value of smoothed said estimated auditory masking.

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33.    The sound decoding apparatus according to claim 29, wherein said enhancement layer decoding section calculates for each frequency an amplitude value difference between either an estimated error spectrum  
25    or error spectrum and either auditory masking or estimated auditory masking, and determines an amount of decoding information based on the amount of said amplitude value difference.

34. The sound decoding apparatus according to claim 29,  
wherein said enhancement layer decoding section decodes  
said error spectrum in a predetermined band in addition  
5 to the frequencies found by said determination section.

35. An acoustic signal transmitting apparatus  
comprising:

an acoustic input section that converts an acoustic  
10 signal to an electrical signal;

an A/D conversion section that converts a signal  
output from said acoustic input section to a digital  
signal;

the coding apparatus according to claim 1 that  
15 encodes a digital signal output from said A/D conversion  
section;

an RF modulation section that modulates coding  
information output from said coding apparatus to a radio  
frequency signal; and

20 a transmitting antenna that converts a signal output  
from said RF modulation section to a radio wave, and  
transmits that radio wave.

36. An acoustic signal receiving apparatus comprising:  
25 a receiving antenna that receives a radio wave;  
an RF demodulation section that demodulates a signal  
received by said receiving antenna;  
the decoding apparatus according to claim 18 that

decodes information obtained by said RF demodulation section;

a D/A conversion section that converts a signal output from said decoding apparatus to an analog signal;

5 and

an acoustic output section that converts an electrical signal output from said D/A conversion section to an acoustic signal.

10 37. A communication terminal apparatus comprising the acoustic signal transmitting apparatus according to claim 35.

38. A communication terminal apparatus comprising the  
15 acoustic signal receiving apparatus according to claim 36.

39. A base station apparatus comprising the acoustic  
20 signal transmitting apparatus according to claim 35.

40. A base station apparatus comprising the acoustic signal receiving apparatus according to claim 36.

41. A coding method comprising:  
25 a step of lowering a sampling rate of an input signal;  
a step of coding an input signal of which sampling rate is lowered and obtaining first coding information;  
a step of generating a decoded signal based on said

first coding information;

a step of raising a sampling rate of said decoded signal to a rate identical to that of said input signal;

a step of using a parameter obtained in processing  
5 that generates said decoded signal, coding a difference value between said input signal and said decoded signal of which sampling rate is raised, and obtaining second coding information; and

a step of multiplexing said first coding information  
10 and said second coding information.

42. A decoding method comprising:

a step of decoding first coding information and obtaining a first decoded signal;

15 a step of decoding second coding information and obtaining a second decoded signal;

a step of raising a sampling rate of said first decoded signal to a rate identical to that of said second decoded signal; and

20 a step of adding said first signal of which sampling rate is raised and said second signal.